MISCELLANEOUS TOPICS COVERED AT THE 1996 WINTER TRAINING MEETINGS

This memorandum will summarize some of the pertinent questions that were raised during the instruction of the 1996 Trenching and Shoring Class. It seemed appropriate that this information be included in the Trenching and Shoring Manual to ensure uniformity and to enhance what was presented at the training sessions.

1. Is the use of the 'flagpole' method acceptable?

Generally the flagpole method refers to an analysis procedure shown in the Uniform Building Code; Section 1806.7.2.1 ('94 UBC), Section 2907 ('91 UBC).

Discussion with ICBO (International Conference of Building Officials) the publishers of the Uniform Building Code revealed that this method was incorporated into their code at the request of the outdoor advertising industry. The official implied that it would not prudent to use. this method as an analysis tool for excavation type work. It is important that if the UBC method is chosen, that it be used consistently with the tables published with that method.

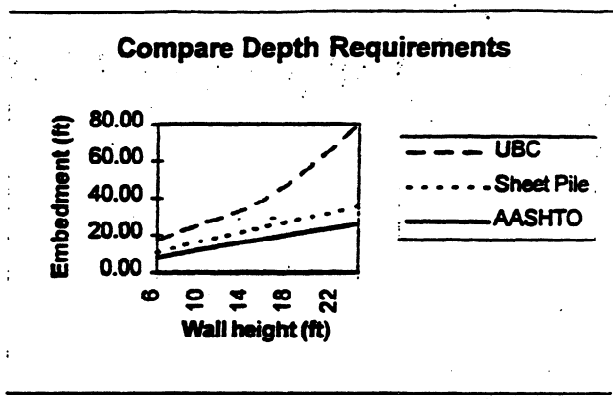
The following chart shows a comparison of unfactored embedment depth between three methods of analysis for a soldier pile wall for both a 72 psf and 100 psf surcharge load. The three methods represented here are the following:

•Uniform Building Code, Section 1806.7.2.1 ('94 UBC), Section 2907 ('91 UBC).
• AASHTO method of analysis for temporary flexible cantilevered walls with discrete vertical wall elements.
•Sheet pile analysis for soldierpile walls.

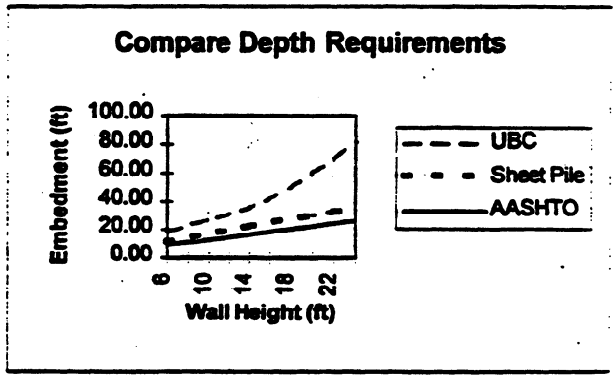
The soil properties for this example are as follows:

H = 8 '
γ = 120 pcf
ϕ = 30°
b = 1' round pile.

Surcharge = 72 psf			
H	AASHTO	UBC	Sheet Pile
6	7.95	16.70	10.52
8	10.08	21.30	13.43
10	12.20	25.80	16.32
12	14.12	29.80	18.95
14	16.06	33.80	21.61
16	18.03	39.80	24.30
18	20.02	48.00	27.02
20	22.02	58.00	29.75
22	24.04	68.60	32.51
24	26.07	80.00	35.27



Surcharge = 100 psf			
H	AASHTO	UBC	Sheet Pile
6	9.58	17.90	11.17
8	11.11	22.50	14.12
10	12.79	27.00	17.10
12	14.66	30.90	19.60
14	16.56	34.90	22.21
16	18.49	42.00	24.85
18	20.44	50.00	27.53
20	22.41	60.00	30.22
22	24.40	70.00	32.94
24	26.41	82.00	35.68



As can be seen-from the charts, the UBC method appears very conservative. If a designer chooses to use pressures other than those from the charts listed within the code, then the accuracy of using this method diminishes.

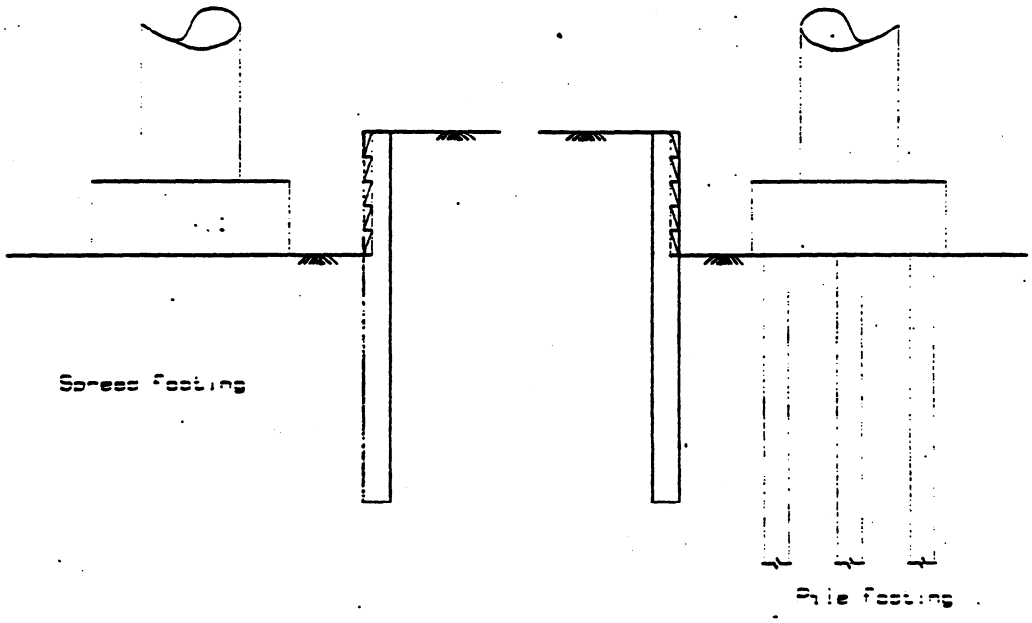
2. May an existing footing be used to increase the passive pressure?

Existing footings may be used to increase the passive resistance on the embedment depth of soldier or sheet piles. To determine the amount of aid it may offer, several methods can be used to determine the amount of lateral pressure the footing applies to piles. Two of these methods are:

1) Boussinesq equation
2) $(\gamma + q)K_pD$
   Where :
   Y = Unit weight of the soil
   q = Uniform surcharge pressure
   D = Depth of embedment
   K_p = Coefficient of passive pressure for the soil.

Because there is often a gap of four or more feet between the shoring system and the footing for most footing retrofits, the Boussinesq equation recommended for determining the amount of pressure acting against the embedded depth of the pile.

If the footing is tight against the shoring system, adding the surcharge to the unit weight of the soil and multiplying by the appropriate K_p value as shown above would be an acceptable alternative to using the Boussitiesq equation. Before doing so, ensure that the passive wedge acts within the width of the footing.



This methodology is applicable for both spread and pile footings. If the permanent piles are to be utilized as part of the retention system, then a rigorous analysis should be

submitted verifying the-resisting capabilities of the piles.

When strutting against an existing footing, the permanent structure piles should not be subjected to a load greater than 13 kips/pile.

3. What is the effect of reducing K_p in lieu of increasing embedment depth (D) by 20 - 40%.

As discussed on page 8-3 of the Trenching and Shoring Manual, passive resistance should be initially reduced by dividing K_p by 1.5 to l.75; or alternatively increase the computed D (depth of embedment) by 20% to 40% The preferred method is to adjust K_p, but either approach is acceptable. Using an adjustment of Kp agrees with what Bowles says in his book Foundation Analysis and Design.

The following results reflect what occurs when both methods are applied to the problems in the handout from the '96 Trenching and Shoring class:

1. Sheet pile problem

   Original

   $K_p = 3.0$
   D = 15.8' D*1.3 = 20.5'
   $S_{req} = 23.4\ in^3$

   Reduce K_p

   $K_p = 3.0/1.5 = 2.0$
   D = 21.3'
   $S_{req} = 31.8\ in^3$

2. Soldier pile problem

   Original (Sheet pile analysis)

   $K_p = 3.0$
   D = 14.9' D*1.2 = 17.8'
   $S_{req} = 135\ in^3$

Reduce K_p (Sheet pile analysis)

K_p = 3.0/1.5 = 2.0
D = 19.8'
S_{req} = 186 in^3

3. Soldier pile problem

Original (AASHTO analysis)

K_p = 3.0
D = 13.1' D*1.2 = 16.0'
S_{req} = 122 in^3

Reduce K_p (Sheet pile analysis)

K_p = 3.0/1.5 = 2.0
D = 16.0
S_{req} = 141 in^3

4. Are photocopies of the PE's signature and stamp acceptable on copies of plans or must the PE stamp and sign each photocopy submitted?

According to the Board of Registration, photocopies of original sealed/signed plans would be satisfactory in meeting the intent of the business and professional code. The engineer of record is responsible for changes that have been made to the plans provided that the engineer of record is aware of the changes made.

5. What does Cal-OSHA require for minimum surcharge loads and to what depth do we carry the surcharge load?

Cal-OSHA does not have a minimum surcharge load that needs to be carried for engineered systems. The Trenching and Shoring Manual states that you should use a minimum surcharge load of 72 psf (3510 N/m^2) This was derived from the Tables in Appendix C to Section 1541.1 of the Construction Safety Orders which includes a 2 ft (610 mm) height of soil. This 2 ft (610 mm) height of soil equates to a 72 psf (3510 N/m^2 load against the shoring when the following soil parameters are used:

$\phi = 30°$, $\gamma = 110$ pcf (17 280 N/m^3)

The minimum surcharge (72 psf, 3510 N/m^2) reflects miscellaneous loads that may be adjacent to a shoring system that may not have been taken into account by the designer of the shoring system. Miscellaneous loads include such items as portable generators, small pickup trucks, workers etc. Loads of any substantial magnitude should be reviewed individually and not be assumed to be included in the minimum surcharge load.

It will be Division of Structures policy that the minimum surcharge load will be used with all shoring systems except when a surcharge from another source causes a lateral pressure of greater magnitude to be used. The lateral pressure from the minimum surcharge load will be carried to the bottom of the excavation or 10 ft (3.05 m), whichever is less.

6. How should surcharge loads be applied to shoring systems?

For the minimum surcharge load (72 psf, 3510 N/m^2), or alternate traffic surcharge (100 psf, 4790 N/m^2) carry the load to the bottom of the excavation or 10 ft (3.05 m) whichever is less. For building or other surcharges, carry the pressures developed from these surcharge loads to a depth where the pressure exerted by the surcharge is 100 psf (4790 N/m^2) or less. At this point the surcharge may be discontinued provided it is below the bottom of the excavation.

Surcharges due to Railroad loadings (Cooper E-80) will be carried to the bottom of the shoring system. In the case of sheet and soldier pile systems, the pressures developed from the railroad surcharge is applied from the top of the shoring system to the tip of the pile.

7. Will railroads allow tieback anchors under their tracks to remain in place after excavation is complete or will the anchor need to be removed?

The Southern Pacific Transportation Company response to this question was that it would be on a case by case basis, Some factors affecting their decision would be the future use of their facility and depth of the anchor. The contractor should contact the railroad company to determine

if the anchor may be left in place. The date/time and the person spoken to should all be included in the submitted plan.

8. Railroad approval

Railroad approval may take the form of no exceptions taken, rejected, or exceptions taken.

In the case of "rejection", the contractor will need to correct and resubmit the plans to the Structure Representative for approval. A satisfactory resubmittal should be forwarded to the falsework engineer for Railroad approval following the same procedures for all shoring and falsework plans involving railroads.

In the case of exceptions taken, the contractor will still need to correct the deficiencies and resubmit the shoring plan to the Structure Representative for review. Provided the contractor made the necessary changes to the plan as requested by the railroad, then resubmitting the plan to the railroad will not be necessary.

9 . Grades on adjacent railroad tracks

When shoring is adjacent to railroad tracks it is important to monitor track settlement during all stages of shoring construction Grades should be established on the tie plates since they have a tendency to move or settle with the tie. Grades on the rail itself may be erroneous due to the rails ability to bridge across some of the low ties in an unloaded condition. Choose tie plates that do not move when trains cross over them.